CLAIMS

What is claimed is:

1. A method of cooling an imaging ultrasonic transducer in an imaging ultrasonic transducer system, wherein a patient-contacting surface of said imaging ultrasonic transducer is pressed externally against the skin of a patient in order to generate an image, comprising the steps of:

determining a temperature of the imaging ultrasonic transducer; and

implementing a parameter change in at least one mutable system parameter of the imaging ultrasonic transducer based on the determined temperature, wherein an amount of change in the at least one mutable system parameter is based on an amount of temperature variation from a predetermined operating temperature value;

wherein said parameter change will cause a reduction, if necessary, in the temperature of the patient-contacting surface of the imaging ultrasonic transducer to prevent at least one of pain to the patient and damage to the skin of the patient caused by the temperature of the patient-contacting surface.

2. The method of claim 1, wherein the step of implementing a paramter change in at least one mutable system parameter based on the determined temperature of the imaging ultrasonic transducer comprises the steps of:

determining if the determined temperature is greater than, or equal to, a threshold temperature; and

implementing, if it is determined that the determined temperature is greater than, or equal to, a threshold temperature, the parameter change in at least one mutable system parameter.

3. The method of claim 2, wherein the step of implementing, if it is determined that the determined temperature is greater than, or equal to, a threshold temperature, the parameter change in at least one mutable system parameter comprises the steps of:

if the imaging mode is the fundamental mode,
reducing an applied voltage to the transmitting elements in the ultrasonic transducer;
if the imaging mode is the harmonic mode,
reducing a frame rate of the ultrasonic transducer; and
if the imaging mode is the color flow imaging mode,
reducing a color sector width;
wherein said reduction is proportionate to the amount of temperature variation from the predetermined operating temperature value.

4. The method of claim 3, wherein the step of implementing, if it is determined that the determined temperature is greater than, or equal to, a threshold temperature, the parameter change in at least one mutable system parameter further comprises the steps of:
before the step of reducing the color sector width,
determining if the color sector width is at a minimum level,
changing to the fundamental imaging mode if the color sector width is at a minimum level; and
before the step of reducing the frame rate,
determining if the frame rate is at a minimum level,
changing to the fundamental imaging mode if the frame rate is at a minimum level.

5. The method of claim 1, wherein the step of implementing a parameter change in at least one mutable system parameter based on the determined temperature is comprised of the step of:
using a closed loop feedback control algorithm to adjust the at least one mutable system parameter, wherein the feedback is the amount of temperature variation from the predetermined operating temperature value.

6. The method of claim 5, wherein the closed loop feedback control algorithm is one of linear and nonlinear.

7. The method of claim 1, wherein the step of implementing a parameter change in the at least one system parameter uses a proportional-integral-derivative (PID) algorithm to determine the amount of change in the at least one mutable system parameter based on the amount of temperature variation from the predetermined operating temperature value.

8. The method as recited in claim 1, wherein the at least one mutable system parameter comprises at least one of:

duty cycle, wherein the duty cycle is the ratio of the time in which the ultrasonic transducer is transmitting to the time in which the ultrasonic transducer is receiving;

applied voltage to the transmitting elements in the ultrasonic transducer;

frequency of the ultrasonic sound waves;

frame rate of the ultrasonic transducer;

pulse repetition frequency (PRF) of the ultrasonic transducer;

aperture of the ultrasonic transducer;

imaging depth of the ultrasonic transducer;

sector width of the ultrasonic transducer; and

imaging mode of the ultrasonic transducer.

9. The method of claim 1, further comprising the step of:

resetting the at least one mutable system parameter back to an original state, said original state being a state of the at least one mutable system parameter before the parameter change was implemented.

10. The method of claim 9, wherein the resetting step is at least one of: a) initiated by an operator of the ultrasonic transducer system, b) initiated by the ultrasonic transducer system when the ultrasonic transducer has cooled sufficiently, and c) initiated by the ultrasonic transducer system after a prescribed period of time.

11. The method of claim 9, wherein the step of resetting comprises the steps of:

determining whether the determined temperature is at least one of less than or equal to the predetermined operating temperature value; and

resetting the at least one mutable system parameter back to the original state if the determined temperature is the at least one of less than or equal to the predetermined operating temperature value.

12. The method of claim 1, wherein the amount of change is either an increase or decrease in the value of the at least one mutable system parameter, and further wherein the parameter change causes an increase in the temperature of the patient-contacting surface of the imaging ultrasonic transducer.

13. The method as recited in claim 1, further comprising the steps of:

determining whether the determined temperature of the ultrasonic transducer is greater than or equal to a critical temperature;

turning the ultrasonic transducer off if it is determined that the determined temperature is greater than or equal to the critical temperature; and

once the ultrasonic transducer has been turned off:

determining the current temperature of the ultrasonic transducer;

determining whether the current temperature is less than the critical temperature; and

turning the ultrasonic transducer back on if it is determined that the current temperature is less than the critical temperature.

14. A system for cooling an imaging ultrasonic transducer in an imaging ultrasonic transducer system, wherein a patient-contacting surface of said imaging ultrasonic transducer is pressed externally against the skin of a patient in order to generate an image, comprising:

at least one temperature sensor for sensing the temperature of at least a portion of the ultrasonic transducer; and

a controller for implementing a parameter change in at least one mutable system parameter depending on the sensed temperature, wherein an amount of change in the at least one mutable system parameter is based on an amount of temperature variation from a predetermined operating temperature value;

wherein said parameter change will cause a reduction, if necessary, in the temperature of the patient-contacting surface of the imaging ultrasonic transducer to prevent at least one of pain to the patient and damage to the skin of the patient caused by the temperature of the patient-contacting surface.

15. The system of claim 14, wherein the controller determines if the sensed temperature is greater than, or equal to, a threshold temperature and implements, if it is determined that the determined temperature is greater than, or equal to, a threshold temperature, the parameter change in at least one mutable system parameter.

16. The system of claim 14, wherein the controller uses a closed loop feedback control algorithm to adjust the at least one mutable system parameter, wherein the feedback is the amount of temperature variation from a predetermined operating temperature value.

17. The system as recited in claim 14, wherein the at least one mutable system parameter comprises at least one of:

duty cycle, wherein the duty cycle is the ratio of the time in which the ultrasonic transducer is transmitting to the time in which the ultrasonic transducer is receiving;

applied voltage to the transmitting elements in the ultrasonic transducer;

frequency of the ultrasonic sound waves;

frame rate of the ultrasonic transducer;

pulse repetition frequency (PRF) of the ultrasonic transducer;

aperture of the ultrasonic transducer;

imaging depth of the ultrasonic transducer;

sector width of the ultrasonic transducer; and

imaging mode of the ultrasonic transducer.

18. A method of controlling the temperature of the patient-contacting surface of an imaging ultrasonic transducer which is pressed externally against the skin of a patient in order to generate an image, comprising the steps of:

determining a temperature of the patient-contacting surface of the imaging ultrasonic transducer; and

implementing a parameter change in at least one mutable system parameter of the imaging ultrasonic transducer based on the determined temperature, wherein an amount of change in the at least one mutable system parameter is determined using a closed loop feedback control algorithm, wherein the feedback comprises the determined temperature of the patient-contacting surface of the imaging ultrasonic transducer;

wherein said parameter change will cause a reduction, if necessary, in the temperature of the patient-contacting surface of the imaging ultrasonic transducer to prevent at least one of pain to the patient and damage to the skin of the patient caused by the temperature of the patient-contacting surface.

19. The method of claim 18, wherein the amount of change is either an increase or decrease in the value of the at least one mutable system parameter, and further wherein the parameter change causes an increase in the temperature of the patient-contacting surface of the imaging ultrasonic transducer.

20. The method of claims 18, wherein the closed loop feedback control algorithm comprises a "semi-closed" loop feedback control algorithm.